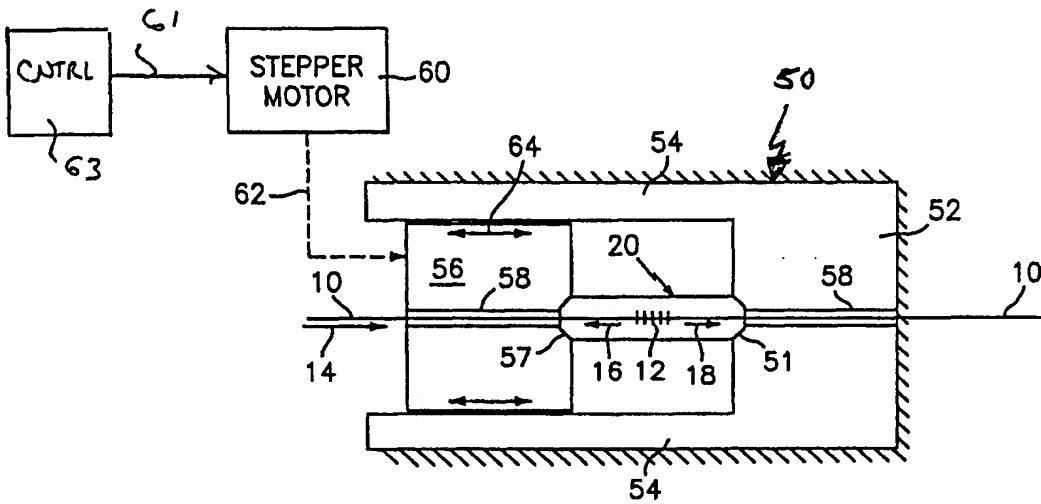


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> :  G02B 6/34, H01S 3/067		A3	(11) International Publication Number: <b>WO 00/37969</b>
			(43) International Publication Date: 29 June 2000 (29.06.00)
(21) International Application Number: PCT/US99/28999			
(22) International Filing Date: 6 December 1999 (06.12.99)			
(30) Priority Data: 09/205,846 4 December 1998 (04.12.98) US 09/400,362 20 September 1999 (20.09.99) US Not furnished 6 December 1999 (06.12.99) US			(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
(71) Applicant: CIDRA CORPORATION [US/US]; 50 Barnes Park North, Wallingford, CT 06492 (US).			
(72) Inventors: FERNALD, Mark, R.; 35 Tyler Road, Enfield, CT 06082 (US). BAILEY, Timothy, J.; 703 Maple Road, Longmeadow, MA 01106 (US). MILLER, Matthew, B.; 140 Deerfield Drive, Glastonbury, CT 06033 (US). SULLIVAN, James, M.; 465 Buckland Hills Drive, Manchester, CT 06118 (US). DAVIS, Michael, A.; 172 Stevens Lane, Glastonbury, CT 06033 (US). BRUCATO, Robert, N.; 268-1 Scott Road, Waterbury, CT 06410 (US). KERSEY, Alan, D.; 75 Taylor Town Road, South Glastonbury, CT 06073 (US). PUTNAM, Martin, A.; 78 Lancaster Way, Cheshire, CT 06410 (US). SANDERS, Paul, E.; 1 Centre Village Drive, Madison, CT 06443 (US).			Published <i>With international search report.</i>
			(88) Date of publication of the international search report: 16 November 2000 (16.11.00)

(54) Title: COMPRESSION-TUNED BRAGG GRATING AND LASER



## (57) Abstract

A compression-tuned Bragg grating includes a tunable optical element 20, 600 which includes either an optical fiber (10) having at least one Bragg grating (12) impressed therein encased within and fused to at least a portion of a glass capillary tube (20) or a large diameter waveguide grating (600) having a core and a wide cladding. Light (14) is incident on the grating (12) and light (16) is reflected at a reflection wavelength  $\lambda_1$ . The tunable element 20, 600 is axially compressed which causes a shift in the reflection wavelength of the grating (12) without buckling the element. The shape of the element may be other geometries (e.g., a "dogbone" shape) and/or more than one grating or pair of gratings may be used and more than one fiber (10) or core (612) may be used. At least a portion of the element may be doped between a pair of gratings (150, 152), to form a compression-tuned laser or the grating (12) or gratings (150, 152) may be constructed as a tunable DFB laser. Also, the element (20) may have an inner tapered region (22) or tapered (or fluted) sections (27). The compression may be done by a PZT, stepper motor or other actuator or fluid pressure.

***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/28999

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 G02B6/34 H01S3/067

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G02B H01S G01D G01K G01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data, INSPEC

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category <sup>o</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	US 5 999 546 A (JIN SUNGHO ET AL) 7 December 1999 (1999-12-07)  column 1, line 31 - line 36 column 3, line 12 - line 20; figure 1 column 4, line 25 - line 30; figure 2 column 4, line 47 - line 56; figure 4 ---	1,2,7, 12-14, 17,18, 22,23, 27-29,37
P,X	WO 98 59267 A (INGLIS HUGH GREGORY ;UNIPHASE FIBRE COMPONENTS PTY (AU); BULMAN J0) 30 December 1998 (1998-12-30) page 2, line 27 - last line page 6, line 14 -page 7, line 6; figures 3A,B --- -/-	1,7,17, 22,37

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

<sup>o</sup> Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

4 August 2000

17/08/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Ciarrocca, M

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 99/28999

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	DE 197 24 528 A (INST PHYSIKALISCHE HOCHTECHNOL) 24 December 1998 (1998-12-24)	1,2,7,9, 17,18, 22,23,37
A	page 3, line 12 - line 13 page 3, line 26 - line 28; figure 1 page 3, line 40 - line 52; figure 2 ----	4
X	US 5 841 131 A (UDD ERIC ET AL) 24 November 1998 (1998-11-24)	1,2,7,8, 12,18
A	column 12, line 23 -column 13, line 3; figures 21-25 ----	4,22
X	WO 95 30926 A (UNIV SYDNEY ;HILL PETER (AU); ATKINS GRAHAM (AU); SCEATS MARK (AU)) 16 November 1995 (1995-11-16)	1,7, 18-22, 32,33,37
A	page 11, line 21 - line 27; figure 7 claims 1,3,5 ----	2-4,23, 25
Y	US 5 699 377 A (PAN JING-JONG) 16 December 1997 (1997-12-16)	1,2,7, 17,18, 22,23,37
	column 4, line 7 - line 15 column 4, line 50 -column 5, line 14 figure 4 ----	
Y	WO 82 04328 A (GOULD INC) 9 December 1982 (1982-12-09)	1,2,7, 17,18, 22,23,37
	page 2, line 8 - line 16 page 5, line 22 -page 6, line 23 page 14, line 28 -page 15, line 13 page 17, line 30 -page 18, line 16 ----	
A	CRUZ J L ET AL: "IMPROVED THERMAL SENSITIVITY OF FIBRE BRAGG GRATINGS USING A POLYMER OVERLAYER" ELECTRONICS LETTERS, GB, IEE STEVENAGE, vol. 32, no. 4, 15 February 1996 (1996-02-15), pages 385-387, XP000558169 ISSN: 0013-5194 page 385, right-hand column, paragraph 3 page 386, left-hand column, last paragraph -right-hand column, paragraph 1 ----	1,2,18, 22,23
	----	

## INTERNATIONAL SEARCH REPORT

Interr 1al Application No  
PCT/US 99/28999

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>LO Y L: "USING IN-FIBER BRAGG-GRATING SENSORS FOR MEASURING AXIAL STRAIN AND TEMPERATURE SIMULTANEOUSLY ON SURFACES OF STRUCTURES"            OPTICAL ENGINEERING, US, SOC. OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS. BELLINGHAM,            vol. 37, no. 8,            1 August 1998 (1998-08-01), pages 2272-2276, XP000789084            ISSN: 0091-3286            abstract</p> <p>---</p>	1,22
A	<p>US 5 469 520 A (MOREY WILLIAM W ET AL)            21 November 1995 (1995-11-21)            cited in the application            abstract            column 4, line 10 - line 25; figure 3</p> <p>---</p>	1,18,22, 34
A	<p>US 5 691 999 A (BALL GARY A ET AL)            25 November 1997 (1997-11-25)            cited in the application            abstract; figure 1</p> <p>---</p>	1,12-16, 18,22, 27-31,34
A	<p>US 5 042 898 A (GLOMB WALTER L ET AL)            27 August 1991 (1991-08-27)            cited in the application            column 6, line 65 - column 7, line 36;            figure 4</p> <p>-----</p>	1,17,18, 22

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Interr. national Application No

PCT/US 99/28999

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
US 5999546	A 07-12-1999	NONE			
WO 9859267	A 30-12-1998	AU 7898898 A	EP 0990179 A		04-01-1999 05-04-2000
DE 19724528	A 24-12-1998	NONE			
US 5841131	A 24-11-1998	AU 8288398 A	EP 0995091 A	NO 20000039 A	08-02-1999 26-04-2000 07-03-2000
		WO 9902953 A			21-01-1999
WO 9530926	A 16-11-1995	AU 2341395 A			29-11-1995
US 5699377	A 16-12-1997	NONE			
WO 8204328	A 09-12-1982	US 4444458 A	EP 0079938 A	JP 58500819 T	24-04-1984 01-06-1983 19-05-1983
US 5469520	A 21-11-1995	CA 2200723 A	EP 0783718 A	JP 10505920 T	11-04-1996 16-07-1997 09-06-1998
		WO 9610765 A			11-04-1996
US 5691999	A 25-11-1997	CA 2200569 A	DE 69506273 D	DE 69506273 T	11-04-1996 07-01-1999 22-04-1999
		EP 0783780 A	ES 2125664 T	JP 10507036 T	16-07-1997 01-03-1999 07-07-1998
		WO 9610854 A			11-04-1996
US 5042898	A 27-08-1991	DE 69020167 D	DE 69020167 T	EP 0507877 A	20-07-1995 26-10-1995 14-10-1992
		WO 9110151 A			11-07-1991